6.0 Introduction

Overview of Chapter 6

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RISC provides flexibility in selecting the type of remedy that best achieves closure goals for the site. Closure can be achieved with or without institutional controls.

The goal of RISC procedures is to reach closure, which is defined as:

> IDEM's written recognition that a party has demonstrated attainment of specific remedial or screening objectives (closure levels) for COCs at a particular area.
>
> Note: Under the Resource Conservation and Recovery Act (RCRA), the term closure refers to a series of formal procedures required to end the operation of a permitted treatment, storage, or disposal (TSD) unit.

IDEM remedial programs may provide closure in the following situations:

1. For source areas that pass area screening tests

2. If a determination of the nature and extent of contamination indicates that constituent concentrations in all source areas are less than residential closure levels and additivity has been considered

3. If COC concentrations exceed residential closure levels but are less than industrial closure levels, provided appropriate institutional controls are in place and additivity has been considered

The RISC User's Guide should be consulted for program-specific variations to the above criteria.

The default closure tables (Appendix 1) provide the concentration standards mentioned above. For those compounds not listed in the Appendix 1 tables, concentration standards for closure may be calculated using the default equations (Table C), and substituting the appropriate exposure assumptions (Table D), the physical and chemical parameters from the references listed in Appendix 1 page 2 (in order of preference) and the toxicity criteria from the references listed in Appendix 1 page 4 (in order of preference).

IDEM recognizes closure by issuing various documents, depending on the program involved. Table 6-1 indicates the documentation different remediation programs issue to recognize that closure is granted to the extent of that program's authority.

The closure document indicates the extent of completion of the task. New information about the presence of contaminants at a site may require post-closure responses. IDEM may invalidate any closure upon the discovery of new information that indicates a potential threat to human health or the environment. In addition, closure documents are not issued for parts of a site that have not been sampled. The sections below discuss additivity, closure requirements and institutional controls, closure requirements by media, and programmatic closure considerations.

Table 6-1. Closure Documentation by Program

IDEM Program	Form of Closure Documentation
Leaking Underground Storage Tanks (LUST)	No Further Action (NFA) Letter
State Cleanup	No Further Action (NFA) Letter
RCRA Permitting	Approval of Closure Certification
RCRA Corrective Action	NFA Letter
Voluntary Remediation Program (VRP)	Certificate of Completion and Covenant Not to Sue

6.1 Chemical of Concern Additivity

More than one chemical may be present in a source area. RISC assumes that each individual chemical in a mixture acts in an additive fashion by contributing to a single common toxic effect; this assumption applies to both carcinogenic and noncarcinogenic compounds (except as indicated below). However, it may be possible to demonstrate that the effects of certain mixtures are not additive; in such cases, closure levels for the COCs in question need *not* be adjusted for additivity. Otherwise, additivity must be evaluated quantitatively as indicated below.

6.1.1 Carcinogens

For all carcinogens, additivity should be determined as follows for the exposure pathways and media indicated:

- **soil direct contact** — Compounds in surface soil are additive.

- **soil migration to ground water** — Compounds are not additive.

- **ground water** — Compounds with no established maximum contaminant level (MCL) are additive.

The total risk from the combined exposure to multiple carcinogens must be less than the target risk level. Using Equation 6-1, the sum of the fractions representing the risk posed by each carcinogen must be less than or equal to 1.0.

Carcinogen Additivity

Equation 6-1. $$\frac{C_1}{CL_1} + \frac{C_2}{CL_2} + \frac{C_3}{CL_3} + ... \frac{C_n}{CL_n} \leq 1.0$$

Where

C_1, ...C_n = Concentration of carcinogenic chemicals in parts per million

CL_1, ...CL_n = Risk based closure level for the specific carcinogenic chemicals in parts per million

6.1.2 Noncarcinogens

All noncarcinogens are considered additive in the following manner:

- **Soil direct contact** — Compounds in surface soil are additive if they have the same critical effect category.

- **Soil migration to ground water** — Compounds are not additive.

- **Ground water** — Compounds with no established MCL are additive if they have the same critical effect.

Individual noncarcinogens may not exceed a hazard quotient of 1.0. In addition, using Equation 6-2, the sum of hazard quotients must be less than or equal to the hazard index of 1.0 per critical effects category (Appendix 1, Table G).

Noncarcinogen Additivity

Equation 6-2. $$\frac{NC_1}{NCL_1}+\frac{NC_2}{NCL_2}+\frac{NC_3}{NCL_3}+\cdots\frac{NC_n}{NCL_n}\leq 1.0$$

Where

NC_1, ...NC_n = Concentration of noncarcinogenic chemicals in parts per million
NCL_1, ...NCL_n = Risk based closure level for noncarcinogens in parts per million

6.2 Closure Requirements and Institutional Controls

After completing the risk assessment and any needed remediation, site conditions must meet the closure criteria listed in this section.

6.2.1 Closure With Institutional Controls

If engineering controls or restrictions of site activities are used to prevent exposure to site contamination, evidence of the suitability, effectiveness, and continued protection of those controls must be supplied. Institutional controls provide this evidence.

Closure with institutional controls generally requires the use of an Environmental Notice, which must provide information on the nature and extent of residual contamination and the methods used to control that contamination. The Environmental Notice must stipulate that the exposure prevention mechanism established at the site will be maintained, and it must prohibit future changes to the site that would interfere with any such mechanism. The Environmental Notice must be recorded on the deed of the affected property. An Environmental Notice is also required for any property where industrial criteria were used to achieve closure. Appendix 5 provides more information on Environmental Notice and ground water ordinance requirements. Nondefault institutional controls are discussed in Chapter 7.

Additional post-closure care activities are required for engineering controls and may be required for activity restrictions (see Chapter 6). In addition, property control must be obtained and demonstrated where a ground water plume has affected an off-site property. Sites where closure has been achieved with institutional controls may pursue closure without institutional controls at any time.

6.2.2 Closure Without Institutional Controls

Closure without institutional controls typically involves removing contaminated media or permanently reducing COC concentrations to less than residential closure levels (or background). COCs are typically remediated either by physical removal and disposal or by physical, chemical, or biological treatment.

6.3 Closure Requirements by Media

The default process requires a minimum number of sample locations to demonstrate that COC concentrations (the potential exposure concentrations) are less than closure levels (or background) for each affected media. Table 6-2 indicates the minimum number of sample locations recommended for closure areas covering 1/10, 1/4, and 1/2, acre. These recommendations apply to closure sampling in surface and subsurface soils. An additional consideration for evaluation of samples collected using random procedures is the coefficient of variation (CV). If the CV (see Chapter 7.9.3.3) for all of the random sample values exceeds 1.2, additional sampling or other actions may be required.

Table 6-2. Recommended Minimum Number of Soil Sample Locations

Closure Area Size	Number of Sample Locations or Borings
1/10 acre	3
1/4 acre	5
1/2 acre	10

The potential exposure concentration (PEC) is the constituent concentration in surface and subsurface soil that is representative of the site mean (based on random sampling), or the highest concentrations at the sample location (based on judgmental sampling). PECs are calculated for comparison of sample data with closure levels. Default closure levels are listed in the Default Closure Table (see Appendix 1). The sampling process generates a PEC for each COC within each of the sampled media. Within the default approach, PEC soil closure analytical data must be evaluated as outlined in the next two sections (chapter 6.3.1 and 6.3.2). Ground water closure criteria are outlined in chapter 6.3.3.

6.3.1 Surface Soil Sampling and Potential Exposure Concentration Evaluation

Surface soil samples should be collected using the most appropriate methodology for the chemical of concern. Numerous EPA and IDEM documents provide guidance on appropriate sampling methodology. Selecting sample locations may involve the use of field instruments, geological information, site history, information gathered during screening and nature and extent evaluations, information related to remedial activities, or other relevant information.

Closure at sites where surface soils have been contaminated requires that PECs be evaluated as follows:

- Judgmental samples – Each COC concentration in samples representing the most highly contaminated locations within the closure area must be less than the land use-specific closure level established for each COC.

- Random samples – The upper confidence limit (UCL) of the mean of COC concentrations in a representative random sample of the source area must be less than the land use-specific closure levels.

The UCL for random samples is calculated using Equation 6-3.

Upper Confidence Limit of the Mean

Equation 6-3. $$CL \geq \bar{x} + \frac{ts}{\sqrt{n}}$$

Where

CL	=	The closure level
$\bar{x}$	=	Mean of the sample set
s	=	Standard deviation of sample values
n	=	Number of samples
t	=	Appropriate value for Students “t” test

Samples collected using purely judgmental approaches may not be evaluated using the upper confidence limit. If judgmental sample data exceed closure levels, three courses of action are possible: (1) use random sampling methods to re-evaluate the source area (2) perform remediation, or (3) proceed to nondefault. If it can be demonstrated that the closure level is exceeded because of naturally occurring

background levels of specific chemicals of concerns, it may be possible to achieve closure even though the concentration exceeds the land-use specific closure level.

6.3.2 Subsurface Soil Sampling and Potential Exposure Concentration Evaluation

When subsurface soil is excavated as part of a remediation, sidewall samples should be taken every 20 feet around the excavation, or a minimum of one sample per sidewall should be collected in smaller excavations. In addition, an appropriate number of samples (see Table 6-2) should be collected from the floor of the excavation. The subsurface soil sampling procedure outlined in Chapters 3 and 4 should be followed.

Selection of soil increments may be based on information gathered during the investigation of the nature and extent of contamination (provided that such an investigation yielded adequate source area information).

Sampling subsurface soil to determine if further action is necessary requires an assessment of the entire source area. To determine the number of increments (or strata) necessary for a PEC determination, two courses of action are possible: (1) verify that two consecutive increments below the extent of contamination have concentrations below detection limits, or (2) collect samples to the depth where constituent concentrations are less than the land use-specific closure level. If the second option is utilized, a ground water sample must be collected from that boring to demonstrate the full extent (see Section 6.3.3).

The closure sampling procedure at sites where subsurface soils have been contaminated evaluates PECs as follows:

- Judgmental samples
  1. Volatile COCs
     - Follow the procedure outlined in chapter 3.4.3.1 for sample collection (steps 1-3) and PEC evaluation (step 4) using the appropriate number of samples as identified in Table 6-2.
  2. Nonvolatile COCs
     - Follow the procedure outlined in chapter 3.4.3.2 for sample collection
     - Using only analytical results from strata with detections, average the data within each boring. If the intervals are not all of the same length,

then the calculation of the average concentration must account for the different lengths of the intervals - see EPA Soil Screening Guidance Technical Background Document chapter 4.2.8.

- Compare each boring analytical average to the appropriate closure level(s).

- Random samples – The upper confidence limit (UCL) of the mean of COC concentrations from every sample collected in a representative random sample of the source area must be less than the land use-specific closure levels.

The UCL for random samples is calculated using Equation 6-3.

6.3.3 Ground Water Closure Requirements

Closure requirements for sites where ground water is affected will depend on site-specific circumstances and the nature of the chemicals of concern. For example, requirements differ for petroleum and chemical releases. For closure with institutional controls, the user must demonstrate that the contaminant plume is stable or shrinking (see Appendix 3). For closure without institutional controls, residential closure levels must be met at all points within the ground water plume.

6.3.3.1 Ground Water Closure Options

A site with ground water contamination may achieve closure using one of two default options:

- Option 1 – By demonstrating that the plume is stable or shrinking (following the procedures in Appendix 3), or

- Option 2 – By demonstrating that ground water concentrations of all COCs are less than closure levels throughout the plume

Closure using default Option 2 may be demonstrated in either of two ways:

1. After ground water remediation is complete, constituent concentrations in the source area must be verified as being less than closure levels. Concentrations may be verified by monitoring one or more wells, as appropriate for the site, in the area of highest constituent concentration. This area may be determined during the course of ground water remediation. To achieve closure in this manner, monitoring well data must

verify that constituent concentrations in ground water are less than closure levels for at least eight consecutive quarters.

2. This method is the same as above except that the UCL for the eight quarters of sampling data (see Equation 6-3) *for each appropriately located well* may be compared to the closure level. If the statistical evaluation indicates that constituent concentrations within the ground water plume are less than the closure level, the site is eligible for ground water closure.

For closure at industrial levels, the appropriate land use designation must be noted on the property deed.

6.3.3.2 Source Considerations

Care should be exercised in determining the appropriate area to evaluate for closure. Many compounds will migrate rapidly through the environment and may move downgradient of the source area.

Unless an area is screened out, the nature and extent of contamination must be determined before a the appropriate area can be delineated for closure sampling. If free product is discovered on ground water, it must be recovered to the extent practicable to reduce potential hazards and limit further COC migration.

6.4 Programmatic Closure Considerations

There may be programmatic closure requirements in addition to RISC considerations. If a source area is closed using engineering controls, activity restrictions, or land use designations, additional requirements may include closure care, assurance of financial responsibility, and reporting. See the RISC User's Guide for specific details regarding program applicability for any of these issues.

6.4.1 Closure Care for Engineering Controls

Engineering controls must be maintained so that they continue to be effective. A detailed description of the engineering controls, including a maintenance schedule, must be supplied to IDEM as part of closure documentation.

6.4.2 Financial Responsibility

A demonstration of financial responsibility may be required to ensure that funds are available to support any required closure care. Financial

responsibility requirements are determined by the specific program's guidance (or by rule).

6.4.3 Reporting

When institutional controls are used as an element of the closure, IDEM may require reporting. Such reporting should be submitted once every 2 years and may include the following:

- An inspection report discussing the condition of the property and maintenance of engineering controls
- The date and time of the inspection
- The name and employer of the inspector
- Any changes in land use since closure or the last report period
- Activities being performed on the property by employees, contractors, or the public
- Any construction activity that has taken place since closure or the previous report period
- A discussion of the effectiveness of the engineering or institutional controls and their effectiveness in preventing exposure to environmental or human health hazards
- A discussion of the soundness of the financial assurance instrument